Sheet (chapter ١)

(١) Find the complement of the following expressions:

a. $xy' + x'y$
b. $(AB' + C)D' + E$
c. $(x + y' + z)(x' + z')(x + y)$

(٢) Draw the logic diagrams for the following Boolean expressions:

a. $Y = A'B' + B(A + C)$
b. $Y = (A + B)(C' + D)$

(٣) Given the Boolean function:

$F = xy + x'y' + y'z$

a) implement it with AND, OR and inverter gates
b) implement it with NOR gates, and
c) implement it with NAND gates.

(٤) Implement the following function using NAND gates then by NOR gates. Which will require less components.

$F = AB' + A'D + BCD'$

Sheet (chapter ٢)

(١) List the truth table of the following functions:

$F(x,y,z) = xy + xy' + y'z$
$Z(A,B,C,D) = AB + CD + AB'C'$
$H(A,B,C,D) = A + CD' + BCD'$

(٢) Given the below truth table, write down the output Z in terms of the inputs. What is this form called?

Inputs			Output
A	B	C	Z
٠	٠	٠	١
٠	٠	١	٠
٠	١	٠	٠
٠	١	١	٠
١	٠	٠	١
١	٠	١	١
١	١	٠	٠
١	١	١	١

(٣) State which of the following terms are in the minterm form and which is not:
XYZ' , XY', X'Z, ABC, AB, C'D
What would you need to determine the type?

(٤) Convert the previous terms into minterms and represent them as m-form.

(٥) Write down the minterms for each of the following cases:
(١) n= ٤, m٩, m١٢
(٢) n=٥, m١٩, m٢٤
(٣) n=٦, m٢٩,m٣١

(٦) Write down the maxterms for the previous question (٥).

(٧) Use the minterm form produced in question ٥ to produce the maxterms using the relation between them.

(٨) Write down the following function represented in the truth table as sum of minterms and product of maxterms. Then put it in a short-notation form.

Inputs			Output
A	B	C	Z
٠	٠	٠	٠
٠	٠	١	١
٠	١	٠	١
٠	١	١	٠
١	٠	٠	١
١	٠	١	١
١	١	٠	١
١	١	١	٠

(٩) Write down the following function in a short notation form:
$F(W,X,Y,Z) = W\,XY\,Z' + W'\,X'\;Y'\,Z + W'\,X'\,Y\,Z'$
(١٠) Represent the previous function in a truth table. Then use it to obtain the maxterm form.

(١١) If you know that:
$F(A,B,C) = \sum m(١, ٣,٦, ٧)$
Can you find the product of maxterms form?
(١٢) Convert the sum of products into sum of minterms:
$F(W,X,Y,Z) = WX + X'YZ + WY'Z'$
$F(X,Y,Z) = X + X'YZ + Y'Z'$
(١٣) Use the truth table to represent the previous sum of products and then use it to obtain the sum of minterms. Which is easier?

(١٤) Simplify the following functions using Boolean algebra:

(a) $F(X,Y,Z) = \sum$ (٠,٢,٦.٧)
(b) $F(A,B,C) = \sum$ (٠,٢,٣,٤,٦)
(c) $F(a,b,c) = \sum$ (٠,١,٢,٣,٧)
(d) $F(x,y,z) = \sum$ (٣,٥,٦,٧)
(e) $F(x,y,z) = xy + x'y'z' + x'yz'$
(f) $F(x,y,z) = x'y' + yz + x'yz'$
(g) $F(A,B,C) = A'B + BC' + B'C'$

Sheet (chapter ٣)

(١) Given the following functions represented in the maps, simplify these functions into sum of products and product of sums forms.

BC \ A	٠	١
٠٠		١
٠١	١	١
١١	١	
١٠	١	

BC \ A	٠	١
٠٠	١	١
٠١	١	١
١١		
١٠	١	

CD \ AB	٠٠	٠١	١١	١٠
٠٠	١		١	١
٠١	١	١	١	١
١١				
١٠	١	١	١	١

CD \ AB	٠٠	٠١	١١	١٠
٠٠	١	١	١	١
٠١	١			
١١		١		
١٠	١	١	١	١

(٢) Represent the following functions in Karnaugh map then simplify them.

(h) $F(X,Y,Z) = \sum$ (٠,٢,٦.٧)
(i) $F(A,B,C) = \sum$ (٠,٢,٣,٤,٦)
(j) $F(a,b,c) = \sum$ (٠,١,٢,٣,٧)
(k) $F(x,y,z) = \sum$ (٣,٥,٦,٧)

(l) F(x,y,z) = xy + x\`y\`z\` + x\`yz\`
(m) F(x,y,z) = x\`y\` + yz + x\`yz\`
(g) F(A,B,C) = A\`B + BC\` +B\`C\`

(٣) Simplify the following functions using Karnaugh map.

(a) $F(x,y,z) = xyz + xy'z + xy'z$

(b) $Z(A,B,C,D) = A'B'C'D + ABCD + AB'C'D + A'BCD' + AB'C'D'$

(c) $H(A,B,C,D) = A'B'C'D + ABCD + AB'C'D + A'BCD + AB'CD' + AB'C'D' + A'BCD' + ABC'D + ABC'D' + A'B'CD'$

(٤) Simplify the previous functions into the form of product of sums using the map.

(٥) Given the below truth table, write down the output Z in terms of the inputs. Then simplify it using the map.

Inputs			Output
A	B	C	Z
٠	٠	٠	١
٠	٠	١	٠
٠	١	٠	٠
٠	١	١	٠
١	٠	٠	١
١	٠	١	١
١	١	٠	١
١	١	١	١

(٦) Simplify the following function represented in the truth table into sum of product and product of sums forms

Inputs			Output
A	B	C	Z
٠	٠	٠	٠
٠	٠	١	١
٠	١	٠	١
٠	١	١	٠
١	٠	٠	١
١	٠	١	١
١	١	٠	١
١	١	١	٠

Sheet (chapter ٤)

(١) Give a definition of a decoder and specify the function it performs.
(٢) Construct the function table and draw the logic diagram for a ٣-to٨ decoder with:
(a) Non-inverted outputs (b) Inverted outputs
(٣) Repeat Question ٢ for a ٤-to-١٦ decoder
(٤) Show how a ٣-to-٨ decoder can be constructed using two ٢-to-٤ decoders with active low enable lines.
(٥) Realize the two ٢-variable functions

$F_{١}(A, B) = A \oplus B$
$F_{٢}(A, B) = A \odot B$

using a single ٢-to-٤ decoder and two external OR gates.
(٦) Realize the two functions given in Prob. ٥ using a single ٢-to-٤ decoder with inverted outputs and two external NAND gates.
(٧) Realize the two ٣-variable functions

$$F_{١}(X, Y, Z) = X + Y'Z$$
$$F_{٢}(X, Y, Z) = X' + YZ'$$

using a single ٣-to-٨ decoder and two external OR gates.
(٨) Realize the two functions given in Prob. ٧ using a single ٣-to-٨ decoder with inverted outputs and two external AND gates.
(٩) Realize the two functions given in Prob. ٧ using a single ٣-to-٨ decoder with inverted outputs and two external NAND gates.
(١٠) Realize the three ٣-variable functions

$$F_{١}(X, Y, Z) = X + (X \oplus Y \oplus Z)$$
$$F_{٢}(X, Y, Z) = X \oplus Y' \odot Z'$$
$$F_{٣}(X, Y, Z) = XY + (Y \odot Z)$$

using a single ٣-to-٨ decoder with inverted outputs and three external AND gates.
(١١) Consider the decoder circuit of Fig. ١. Find a minimum sum-of-products form for $F_{١}$ and for $F_{٢}$.

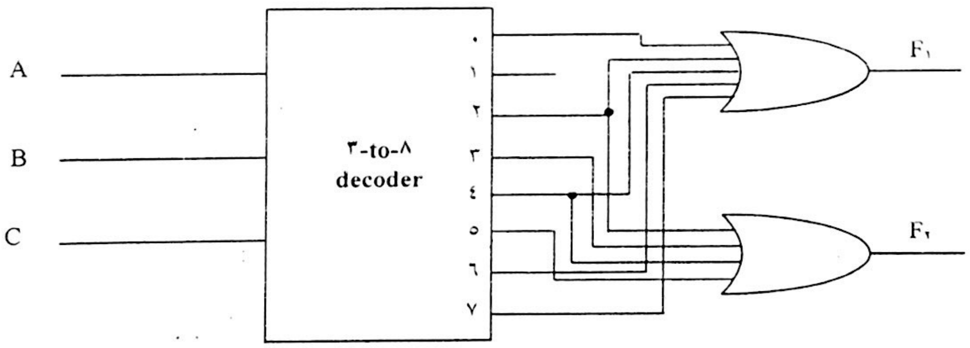

Fig. ١ Decoder circuit for Prob. ١١

(١٢) Consider the decoder circuit of Fig. ٢. Find the minimum product-of-sums form for $F_{١}$ and for $F_{٢}$.

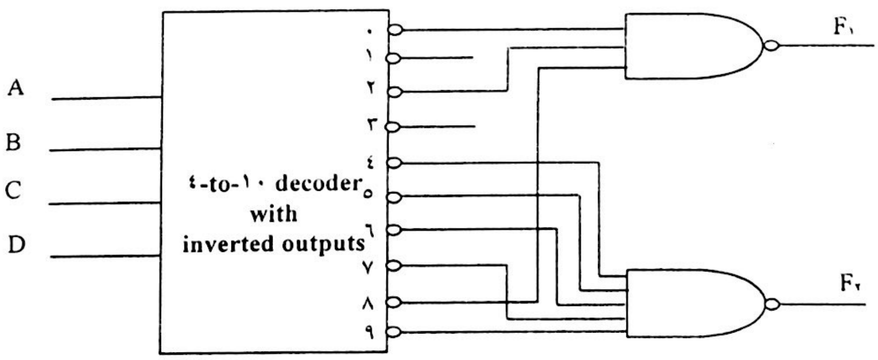

Fig. ٢ Decoder circuit for Prob. ١٢

(١٣) A ٣-to-٨ decoder is used to realize two functions

$$F_{١}(A, B, C) = \sum m(١, ٣, ٤, ٥)$$
$$F_{٢}(A, B, C) = \sum m(٠, ٢, ٥, ٦)$$

which are then fed into a ٢-input XNOR gate to produce a final output Z.

(a) Draw a logic diagram for the complete circuit.
(b) Find the minterm expansion (m-notation) and maxterm expansion (M-notation) of the output Z.
(c) Show that this circuit can be replaced by a single ٢-input AND gate.

(١٤) A ٤-to-١٠ decoder with inverted outputs is used to realize three functions

$$F_{١}(A, B, C, D) = \prod M(٠, ١, ٣, ٩)$$
$$F_{٢}(A, B, C, D) = \prod M(١, ٢, ٤, ٩)$$
$$F_{٣}(A, B, C, D) = \prod M(١, ٣, ٧, ٩)$$

which are then fed into a ٣-input OR gate to produce a final output Z.

(a) Draw a logic diagram for the complete circuit.
(b) Verify that the output Z is independent of the variable A.
(c) Show that this circuit can be replaced by a single ٣-input OR gate.

(١٥) In the decoder circuit of Fig. ٣, find a simplified form for each of the outputs $F_{١}$ and for $F_{٢}$ when the input C is tied to ١.

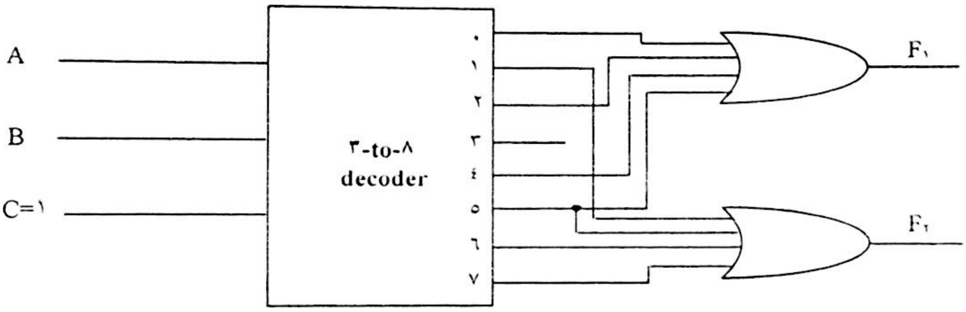

Fig. ٣ Decoder circuit for Prob. ١٥

(١٦) An incompletely specified function is given as

$$F(A, B, C) = \sum m(٥, ٧, ١٣, ١٤, ١٥) + \sum d(١, ٣, ٤, ٦, ٩, ١١, ١٢)$$

Realize the function by:

(a) A ٤-to-١٦ decoder and an external OR gate with a minimum number of inputs.
(b) A ٤-to-١٦ decoder with inverted outputs and an external AND gate with a minimum number of inputs.
(c) A ٤-to-١٦ decoder with inverted outputs and an external NAND gate with a minimum number of inputs.

(١٧) Realize an excess-٣ to BCD code converter using a ٤-to-١٦ decoder with inverted outputs and four external NAND gates.

(١٨) Construct a ٥-to-٣٢-line decoder with four ٣-to-٨-line decoders with enable and a ٢-to-٤-line decoder. Use block diagrams of the components.

(١٩) Construct a ٤-to-١٦-line decoder with five ٢-to-٤-line decoders with enable.

(٢٠) A combinational circuit is defined y the following three Boolean functions:

$F١ = x'y'z' + xz$
$F٢ = xy'z' + x'y$
$F٣ = x'y'z + xy$

Design the circuit with a decoder and external gates.

Sheet (chapter ٥)

١. Design a ٤-input priority encoder with inputs $D_{٠}D_{١}D_{٢}D_{٣}$ with input $D_{٠}$ having the highest priority and input $D_{٣}$ the lowest priority.

٢. Implement the following Boolean function with a multiplexer:

$$F(A, B, C, D) = \sum(٠, ١, ٣, ٤, ٨, ٩, ١٥)$$

٣. Implement a full adder with two ٤ × ١ multiplexers.

٤. An ٨ × ١ multiplexer has inputs A, B, and C connected to the selection inputs $S_{٢}$, $S_{١}$, and $S_{٠}$, respectively. The data inputs $I_{٠}$ through $I_{٧}$, are as follows: $I_{١} = I_{٣} = I_{٧} = ٠$; $I_{٢} = I_{٥} = ١$; $I_{٠} = I_{٤} = D$; and $I_{٦} = D'$. Determine the Boolean function that the multiplexer implements.